

Thresholds

16.4 What are the *absolute* and *difference thresholds*, and do stimuli below the absolute threshold have any influence on us?

absolute threshold the minimum stimulation needed to detect a particular stimulus 50 percent of the time.

signal detection theory a theory predicting how and when we detect the presence of a faint stimulus (*signal*) amid background stimulation (*noise*). Assumes that there is no single absolute threshold and that detection depends partly on a person's experience, expectations, motivation, and alertness.

Try This

Try out this old riddle on a couple of friends. "You're driving a bus with 12 passengers. At your first stop, 6 passengers get off. At the second stop, 3 get off. At the third stop, 2 more get off but 3 new people get on. What color are the bus driver's eyes?" Do your friends detect the signal—who is the bus driver?—amid the accompanying noise?

At this moment, you and I are being struck by X-rays and radio waves, ultraviolet and infrared light, and sound waves of very high and very low frequencies. To all of these we are blind and deaf. Other animals with differing needs detect a world that lies beyond our experience. Migrating birds stay on course aided by an internal magnetic compass. Bats and dolphins locate prey using sonar, bouncing echoing sound off objects. Bees navigate on cloudy days by detecting invisible (to us) polarized light.

The shades on our own senses are open just a crack, allowing us a restricted awareness of this vast sea of energy. But for our needs, this is enough.

Absolute Thresholds

To some kinds of stimuli we are exquisitely sensitive. Standing atop a mountain on an utterly dark, clear night, most of us could see a candle flame atop another mountain 30 miles away. We could feel the wing of a bee falling on our cheek. We could smell a single drop of perfume in a three-room apartment (Galanter, 1962).

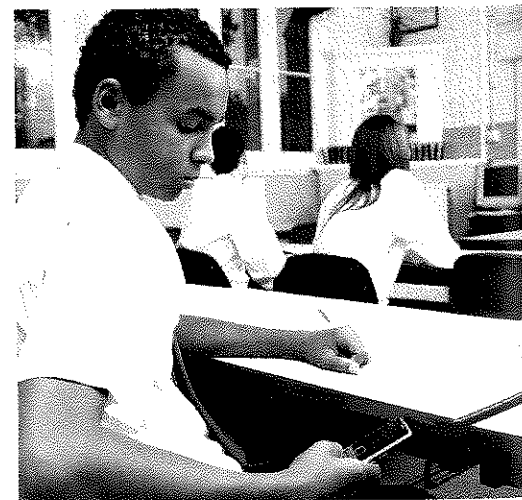
German scientist and philosopher Gustav Fechner (1801–1887) studied our awareness of these faint stimuli and called them our **absolute thresholds**—the minimum stimulation necessary to detect a particular light, sound, pressure, taste, or odor 50 percent of the time. To test your absolute threshold for sounds, a hearing specialist would expose each of your ears to varying sound levels. For each tone, the test would define where half the time you could detect the sound and half the time you could not. That 50-50 point would define your absolute threshold.

Detecting a weak stimulus, or signal, depends not only on the signal's strength (such as a hearing-test tone) but also on our psychological state—our experience, expectations, motivation, and alertness. **Signal detection theory** predicts when we will detect weak signals (measured as our ratio of "hits" to "false alarms") (FIGURE 16.5). Signal detection theorists seek to understand why people respond differently to the same stimuli (have you ever noticed that some teachers are much more likely than others to detect students texting during class?) and why the same person's reactions vary as circumstances change. Exhausted parents will notice the faintest whimper from a newborn's cradle while failing to notice louder, unimportant sounds. Lonely, anxious people at speed-dating events also respond with a low threshold and thus tend to be unselective in reaching out to potential dates (McClure et al., 2010).

Figure 16.5

Signal detection What three factors will make it more likely that you correctly detect a text message?

ANSWER: (1) You are expecting a text message and respond. (2) It is important that you see the message. (3) You are alert.



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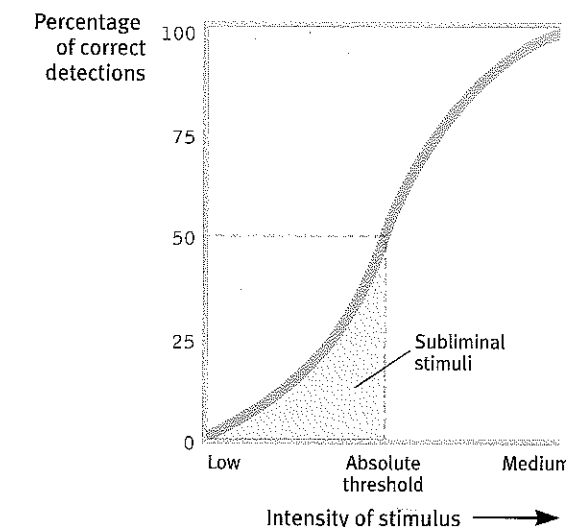


Figure 16.6

Absolute threshold Can I detect this sound? An *absolute threshold* is the intensity at which a person can detect a stimulus half the time. Hearing tests locate these thresholds for various frequency levels. Stimuli below your absolute threshold are subliminal.

Stimuli you cannot detect 50 percent of the time are **subliminal**—below your absolute threshold (FIGURE 16.6). Under certain conditions, you can be affected by stimuli so weak that you don't consciously notice them. An unnoticed image or word can reach your visual cortex and briefly **prime** your response to a later question. In a typical experiment, the image or word is quickly flashed, then replaced by a *masking stimulus* that interrupts the brain's processing before conscious perception (Van den Bussche et al., 2009). For example, one experiment subliminally flashed either emotionally positive scenes (kittens, a romantic couple) or negative scenes (a werewolf, a dead body) an instant before participants viewed slides of people (Krosnick et al., 1992). The participants consciously perceived either scene as only a flash of light. Yet the people somehow looked nicer if their image immediately followed unperceived kittens rather than an unperceived werewolf. As other experiments confirm, we can evaluate a stimulus even when we are not aware of it—and even when we are unaware of our evaluation (Ferguson & Zayas, 2009).

How do we feel or respond to what we do not know and cannot describe? An imperceptibly brief stimulus often triggers a weak response that *can* be detected by brain scanning (Blankenburg et al., 2003; Haynes & Rees, 2005, 2006). Only when the stimulus triggers synchronized activity in several brain areas does it reach consciousness (Dehaene, 2009). Once again we see the dual-track mind at work: *Much of our information processing occurs automatically, out of sight, off the radar screen of our conscious mind.*

So can we be controlled by subliminal messages? For more on that question, see Thinking Critically About: Can Subliminal Messages Control Our Behavior? on the next page.

Difference Thresholds

To function effectively, we need absolute thresholds low enough to allow us to detect important sights, sounds, textures, tastes, and smells. We also need to detect small differences among stimuli. A musician must detect minute discrepancies when tuning an instrument. Students in the hallway must detect the sound of their friends' voices amid all the other voices. Even after living two years in Scotland, sheep *baa's* all sound alike to my ears. But not to those of ewes, which I have observed streaking, after shearing, directly to the *baa* of their lamb amid the chorus of other distressed lambs.



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subliminal below one's absolute threshold for conscious awareness.

priming the activation, often unconsciously, of certain associations, thus predisposing one's perception, memory, or response.

"The heart has its reasons which reason does not know." —PASCAL, *PENSÉES*, 1670

Thinking Critically About

Can Subliminal Messages Control Our Behavior?

Hoping to penetrate our unconscious, entrepreneurs offer audio and video programs to help us lose weight, stop smoking, or improve our memories. Soothing ocean sounds may mask messages we cannot consciously hear: "I am thin"; "Smoke tastes bad"; or "I do well on tests—I have total recall of information." Such claims make two assumptions: (1) We can unconsciously sense subliminal (literally, "below threshold") stimuli. (2) Without our awareness, these stimuli have extraordinary suggestive powers. Can we? Do they?

As we have seen, subliminal *sensation* is a fact. Remember that an "absolute" threshold is merely the point at which we can detect a stimulus *half the time*. At or slightly below this threshold, we will still detect the stimulus some of the time.

But does this mean that claims of subliminal *persuasion* are also facts? The near-consensus among researchers is *No*. The laboratory research reveals a *subtle, fleeting* effect. Priming thirsty people with the subliminal word *thirst* might therefore, for a moment, make a thirst-quenching beverage ad more persuasive (Strahan et al., 2002). Likewise, priming thirsty people with Lipton Iced Tea may increase their choosing the primed brand (Karremans et al., 2006; Veltkamp et al., 2011; Verwijmeren et al., 2011a,b). But the subliminal-message hucksters claim something different: a *powerful, enduring* effect on behavior.

To test whether subliminal recordings have this enduring effect, researchers randomly assigned university students to listen daily for 5 weeks to commercial subliminal messages claiming to improve either self-esteem or memory (Greenwald et al., 1991, 1992). But the researchers played a practical joke and switched half the labels. Some students who thought they were receiving affirmations of self-esteem were actually hearing the memory-enhancement message. Others got the self-esteem message but thought their memory was being recharged.

Were the recordings effective? Students' test scores for self-esteem and memory, taken before and after the 5 weeks,

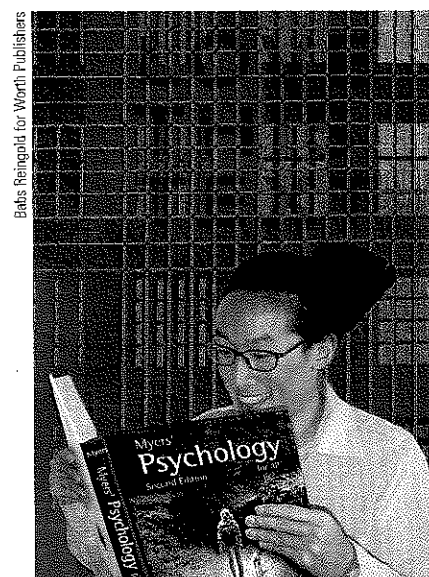


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Subliminal persuasion? Although subliminally presented stimuli can subtly influence people, experiments discount attempts at subliminal advertising and self-improvement. (The playful message here is not actually subliminal—because you can easily perceive it.)

revealed no effects. Yet the students *perceived* themselves receiving the benefits they *expected*. Those who *thought* they had heard a memory recording *believed* their memories had improved. Those who thought they had heard a self-esteem recording believed their self-esteem had grown. (Reading this research, one hears echoes of the testimonies that ooze from ads for such products. Some customers, having bought what is not supposed to be heard [and having indeed not heard it] offer testimonials like, "I really know that your recordings were invaluable in reprogramming my mind.")

Over a decade, Greenwald conducted 16 double-blind experiments evaluating subliminal self-help recordings. His results were uniform: Not one of the recordings helped more than a placebo (Greenwald, 1992). And placebos, you may remember, work only because we *believe* they will work.

The LORD is my shepherd;
I shall not want.
He maketh me to lie down
in green pastures:
he leadeth me
beside the still waters.
He restoreth my soul:
he leadeth me
in the paths of righteousness
for his name's sake.
Yea, though I walk through the valley
of the shadow of death,
I will fear no evil:
for thou art with me;
thy rod and thy staff
they comfort me.
Thou preparest a table before me
in the presence of mine enemies:
thou anointest my head with oil,
my cup runneth over.
Surely goodness and mercy
shall follow me
all the days of my life:
and I will dwell
in the house of the LORD
for ever.

The difference threshold in this computer-generated copy of the Twenty-third Psalm, each line of the typeface increases slightly. How many lines are required for you to experience a just noticeable difference?

The **difference threshold** (or the *just noticeable difference [jnd]*) is the minimum difference a person can detect between any two stimuli half the time. That difference threshold increases with the size of the stimulus. Thus, if you add 1 ounce to a 10-ounce weight, you will detect the difference; add 1 ounce to a 100-ounce weight and you probably will not.

In the nineteenth century, Ernst Weber noted something so simple and so widely applicable that we still refer to it as **Weber's law**. This law states that for an average person to perceive a difference, two stimuli must differ by a constant minimum *percentage* (not a

constant *amount*). The exact proportion varies, depending on the stimulus. Two lights, for example, must differ in intensity by 8 percent. Two objects must differ in weight by 2 percent. And two tones must differ in frequency by only 0.3 percent (Teghtsoonian, 1971). For example, to be perceptibly different, a 50-ounce weight must differ from another by about an ounce, a 100-ounce weight by about 2 ounces.

Sensory Adaptation STOP

16-5 What is the function of sensory adaptation?

Entering your neighbors' living room, you smell a musty odor. You wonder how they can stand it, but within minutes you no longer notice it. **Sensory adaptation** has come to your rescue. When we are constantly exposed to a stimulus that does not change, we become less aware of it because our nerve cells fire less frequently. (To experience sensory adaptation, move your watch up your wrist an inch: You will feel it—but only for a few moments.)

Why, then, if we stare at an object without flinching, does it *not* vanish from sight? Because, unnoticed by us, our eyes are always moving. This continual flitting from one spot to another ensures that stimulation on the eyes' receptors continually changes (**FIGURE 16.7**).

What if we actually could stop our eyes from moving? Would sights seem to vanish, as odors do? To find out, psychologists have devised ingenious instruments that maintain a constant image on the eye's inner surface. Imagine that we have fitted a volunteer, Mary, with one of these instruments—a miniature projector mounted on a contact lens (**FIGURE 16.8a** on the next page). When Mary's eye moves, the image from the projector moves as well. So everywhere that Mary looks, the scene is sure to go.

If we project images through this instrument, what will Mary see? At first, she will see the complete image. But within a few seconds, as her sensory system begins to fatigue, things get weird. Bit by bit, the image vanishes, only to reappear and then disappear—often in fragments (Figure 16.8b).

Although sensory adaptation reduces our sensitivity, it offers an important benefit: freedom to focus on *informative* changes in our environment without being distracted by background chatter. Stinky or heavily perfumed classmates don't notice their odor because, like you and me, they adapt to what's constant and detect only change. Our sensory receptors

difference threshold the minimum difference between two stimuli required for detection 50 percent of the time. We experience the difference threshold as a *just noticeable difference* (or *jnd*).

Weber's law the principle that, to be perceived as different, two stimuli must differ by a constant minimum percentage (rather than a constant amount).

sensory adaptation diminished sensitivity as a consequence of constant stimulation.

"We need above all to know about changes; no one wants or needs to be reminded 16 hours a day that his shoes are on."
—NEUROSCIENTIST DAVID HUBEL (1979)



Figure 16.7 The jumpy eye Our gaze jumps from one spot to another every third of a second or so, as eye-tracking equipment illustrated in this photograph of Edinburgh's Princes Street Gardens (Henderson, 2007). The circles represent fixations, and the numbers indicate the time of fixation in milliseconds (300 milliseconds = three-tenths of a second).

John M. Henderson